3.3 Use Assessment Results, 2007-2008

Section Overview. This section of the IR presents assessment results focused primarily on two BMUs, the Upper Cumberland – 4-Rivers and Green – Tradewater, which were monitored in 2005 and 2006, respectively. However, a statewide summary updating all waters and segments assessed prior to 2005 was incorporated into overall use support summaries and statistics (10,563 miles representing approximately 12 percent of stream miles at a resolution of 1:24,000 [Table 3.3.1-1]) and is presented in the following subsection. Appendix 'A' contains a table with all assessed waters and the support level per use assessed. Targeted and random biosurvey results of streams were presented with particular focus on the two BMUs of this reporting cycle. The KDOW continues to census lakes and reservoirs in the commonwealth, and trend information on these reservoirs is presented following 25 years of data related to trophic state analyses. The COE reservoirs were monitored by that agency, and the results of those data and trophic status of trends were also provided in the lakes section.

3.3.1 Statewide Assessment Results (Use Support)

Targeted Monitoring: Streams and Rivers. For this monitoring and reporting period (Upper Cumberland – 4-Rivers and Green - Tradewater BMUs) there were 563 stream segments representing 2,506 miles assessed in the Upper Cumberland – 4-Rivers BMU and 437 stream segments totaling 2,548 stream miles during the water-years of 2005-2006. These data represent years three and four of the second five-year intensive monitoring effort based on rotating BMUs. Probabilistic monitoring results are included in the targeted monitoring statistics since that method is used for both specific stream reach assessments as well as extrapolation of data for aquatic life use support in a given BMU. Miles of streams and segments that are fully supporting assessed uses (Categories 1, 2 which includes 2B) total 4,538; streams and rivers with segments not fully supporting assessed uses (Categories 4A, 4B, 4C, 5A and 5B) total 6,562 miles (Table

3.3.1-1). The uses most commonly assessed were aquatic life, primary and secondary contact recreation and drinking water. There were 9,184 total stream miles (51.5 percent) fully supporting those six designated uses (Table 3.3.1-2).

Aquatic Life Use. Nonsupport category of warm water and cold water aquatic habitat uses continues to represent the greatest number of assessed stream miles, with 4,474 combined miles (Table 3.3.1-2) representing 47 percent of stream miles assessed for aquatic life use. This increase of 8.4 percent represents an additional 733 miles compared to the 2006 IR reporting cycle (3,741 mi.) (KDOW, 2006b) The frequency of assessed miles not fully supporting is the second highest in the state (by percentage of designated use assessed miles). Compared to the 2004 305(b) report, stream miles that do not support aquatic life use have increased 1,479 miles.

Fish Consumption. The percentage of assessed stream miles that fail to support this DU is 35.3 percent (Table 3.3.1-2), compared to 58.1 percent in the 2006 IR. This is a direct effect of removing the Ohio River stream miles from the Kentucky ADB, a result of this waterbody treated as interstate waters deferring to ORSANCO's 305(b) report for the Ohio River mainstem (ORASANCO, 2008). Besides the statewide fish consumption advisory for mercury, longstanding waterbody-specific consumption advisories for fish remain in effect in several rivers and streams throughout the commonwealth (http://www.water.ky.gov/sw/advisories/). Two new waterbodies were added to the waterbody-specific consumption advisory due to both methylmercury and PCBs: Knox Creek and Fish Trap Lake, both in Pike County. Knox Creek originates in Virginia and is a tributary of Tug Fork River. Fishtrap Lake is approximately 1,100 surface acres and was formed by impounding the Levisa Fork. The fish consumption advisory includes the entire reservoir and the Levisa Fork from the reservoir backwaters to the Kentucky - Virginia state line. Virginia has a similar fish consumption advisory on Knox Creek to headwaters and a portion of Levisa Fork. The primary source of mercury entering waters is thought to be via air emissions. Because of

Table: 3.3.1-1. Size of Surface Waters assigned to reporting categories[1] for Kentucky

Waterbody Type	Category									Total	Total Segments
	1	2	2B[2]	3	4A	4B	4C	5	5B		
RIVER (MILES)	17.30	3870.11	650.70	185.10	396.68	0.00	1.30	6082.77	81.70	10,553.26	1981
FRESHWATER RESERVOIR (ACRES)	53,890.00	65,881.05	12,451.00	0.00	0.00	0.00	459.00	98,866.10	0.00	219,096.15	115
SPRING (MILES)	0.00	0.03	0.00	0.00	0.00	0.00	0.00	10.45	0.50	10.48	12
FRESHWATER LAKE (ACRES)	0.00	315.00	193.00	0.00	0.00	0.00	0.00	256.00	0.00	571.00	12
POND (ACRES)	0.00	3.30	0.00	0.00	0.00	0.00	0.00	1.50	0.00	4.80	2
FRESHWATER WETLANDS (ACRES)	0.00	0.00	0.00	324000.00	0.00	0.00	0.00	0.00	0.00	324,000.00	0

[1]Refer to Table 3.2-1 on page 47 for a definition of each reporting category
[2]"Total in State" sum does not include miles in this subcategory as these miles may also occur in other categories (i.e. 1, 2, 4B, 5 and 5B)

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Table 3.3.1-2. Individual designated use support summary for streams and rivers in Kentucky (miles)

Designated Use	Total in State	Total Assessed	Supporting-Attaining WQ Standards	Supporting-Attaining WQ Standards but Threatened	Not Supporting-Not Attaining WQ Standards	Not Assessed
Warm Water Aquatic Habitat	10,192.55	9,169.85	4,768.35	2.2	4,399.3	1,022.2
Cold Water Aquatic Habitat	365.01	360.61	285.81	0	74.8	4.4
Fish Consumption	10,553.26	1,244.8	805.0	0	439.8	9,308.46
Primary Contact Recreation	10,553.26	4,493.03	1,345.5	0	3,147.53	6,060.23
Secondary Contact Recreation	10,553.26	1,867.68	1,294.85	0	572.83	8,685.58
Drinking Water	869.25	684.35	684.35	0	0	184.9

interstate issues and complexity of identifying all sources of mercury, EPA is conducting national studies and will likely be involved in eventual efforts to calculate TMDLs and reduce mercury inputs by setting new mercury limits.

Polychlorinated biphenyls (PCBs) are man-made chemical products that are similar in structure. These chemicals are toxic and persistent in the environment. In 1976 Congress passed legislation that prohibits the manufacture, process and distribution in commerce of PCBs. Polychlorinated biphenyls contaminate fish flesh in six streams totaling 142.8 miles as listed below:

- Knox Creek from mouth at Tug Fork River to Kentucky - Virginia state line
- Levisa Fork from Fishtrap Lake backwaters to Kentucky - Virginia state line

- Mud River from Hancock Lake Dam to mouth in Logan, Butler and Muhlenberg counties
- Town Branch Creek, headwaters to mouth in Logan, Butler and Muhlenberg counties
- West Fork Drakes Creek, dam at City of Franklin to mouth in Simpson and Warren counties
- Little Bayou Creek from headwaters to mouth in McCracken County

Primary (Swimming) Contact Recreation Use. The percentage of assessed stream miles that do not support primary contact recreation (PCR) is now the highest of all uses at 70.1 percent (Table 3.3.1-2). This represents a 46.6 percent increase over 2006 number of assessed miles not supporting recreation uses. This designated use also represents the second highest number of assessed stream miles, 4,493.03 (Table 3.3.1-2). Note that this designated use applies during the recreation months of May through October.

There continues to be a number of swimming advisories on segments of streams and rivers in Kentucky. Below are the waterbodies and segments where advisories exist. Fish consumption advisories on the Ohio River may be found in Section 3.3.3. One may also access this information at: http://www.water.ky.gov/sw/advisories/swim.htm.

Upper Cumberland River Basin

- Cumberland River from SR 2014 bridge to Pineville SR 66 bridge and from SR 219 bridge to Harlan
- Martins Fork from Harlan to Cawood Water Plant
- Catrons Creek
  Clover Fork

Upper Cumberland River Basin (cont.)

- Straight Creek
- Poor Fork from Harlan to Looney Creek
- Looney Creek from mouth to Lynch Water Plant Bridge

Lower Licking River Basin

- Banklick Creek
- Threemile Creek

North Fork Kentucky River Basin

- North Fork Kentucky River upstream of Chavies to source (headwaters)

Secondary Contact Recreation Use. Secondary contact recreation designated use applies year-round, and criteria for support of this use are based on fecal coliform standard of 2000 colonies/mL in streams, lakes and reservoirs. There are 572.83 miles not supporting this use out of 1867.68 miles of streams assessed. This represents 30.7 percent of assessed waters that do not support this designated use. Compared to 2006 results, this is an increase of 50.4 percent. With the implementation of *E. coli* as the indicator organism for recreation-monitored waters, the SCR use will have decreasing number miles assessed since there are no EPA-recommended criteria based on *E. coli.* No comparison for years prior to the 2006 IR can be made as no assessments for the SCR use in flowing waters were made based on pathogens. In streams and rivers, the secondary contact recreation standard is applied to protect people from incidental water contact or partial body emersion that may occur in such activities as fishing and boating.

Drinking Water Use. Drinking water standards apply to the source water at point of intake. Drinking water use support was assessed by review of the average quarterly results for contaminants as reported in MORs (monthly operating reports that are required by the Safe Drinking Water Act). The average annual result of these quarterly data is determined for compliance purposes. The MCLs (maximum contaminant levels) are based on concentration of each contaminant in the finished product distributed for public consumption. Of those streams assessed, all were fully supporting drinking (domestic) water use.

Probability Monitoring: Aquatic Life Use. A simple question has been asked throughout the 35-year history of the Clean Water Act: "What is the condition (health) of the nation's waters?" Various studies have been undertaken to answer that question. However, findings concluded that while agencies have been good at collecting data about site-specific conditions of states' waters, there exist no data to determine the overall condition and trend of the waters on a national scale. A national study was undertaken to answer that question and related questions (Are water quality [fishable and swimmable] conditions improving? Are there new issues and threats related to aquatic ecosystem health or any successes?) to help citizens determine if more money and resources need to go toward water quality issues, or if the billions of dollars being spent to curb and control pollution is simply not working.

To begin to answer this complex question, it was determined that a statistically valid random biosurvey of the nation's streams was necessary. The EPA oversaw the development and implementation of a random design study of the nation's streams and was able to make substantive decisions concerning the ecological condition of wadeable streams in the contiguous states. The random survey may be likened to a political poll in which a random sample of likely, eligible voters in a given congressional district, or nationally in a presidential race, is polled to discover the likelihood of a particular candidate to win election. In the national survey, all eligible wadeable streams of Strahler order 1-4 in similar ecoregions, or group of similar ecoregions based on biological similarities known as bioregions, define the population from which to randomly select representative stream segments in order to draw scientifically sound conclusions on the findings of those data. The national study segregated the contiguous 48 states into three broad regions defined as West, Eastern Highlands and Lowlands (Wadeable Streams Assessment, USEPA, 2006).

The next national probabilistic study implemented by EPA is to assess the condition of the nation's lakes and reservoirs. The monitoring occurred in summer and fall 2007, and a report on the findings is scheduled for federal fiscal year 2009 (October 2008 – September 2009).

The statewide (over the initial five year BMU-cycle) random wadeable streams biosurvey was completed in the initial phase of the five-year cycle in Kentucky, is now in the second five-year cycle and will be completed at the conclusion of the 2007 water-year. Results for the first completed 5-year cycle (1998 – 2002) were presented in Table 3.3.1-3 and Figure 3.3.1-1 of the 2006 IR (KDOW, 2006b). It is anticipated that statewide results from the second phase of the BMU cycle will be presented in the 2010 IR.

Causes and Sources Related to Nonsupport of Uses. The leading causes (including pollution) for designated use nonsupport of Kentucky streams and rivers are: 1) sedimentation; 2) fecal coliform + *E. coli* (pathogens); 3) nutrient/eutrophication biological indicators; 4) habitat (streams) (pollution); and 5) cause unknown (Table 3.3.1-3). The pollutant that is no longer in the top five most prevalent pollutants in Kentucky are PCBs. This is a result of removing the Ohio River mainstem assessments from Kentucky's ADB and deferring to ORSANCO to report those assessment results in their biennial 305(b) report. The leading sources of these impairments are: 1) habitat related (other than hydromodifications); 2) agriculture; 3) urban or municipal; 4) "source unknown;" and 5) mining (Table 3.3.1-4). For the first time, habitat related (other than hydromodifications) sources are the leading contributor of causes per assessed river mile in the commonwealth. Agriculture sources displaced "source unknown" in 2006 as the number one contributor and is now second, associated with 2,777 miles of nonsupporting streams in Kentucky. The category "Waste Disposal" has the greatest increase of miles since the last biennium, nearly fourfold increase in total miles (609 miles currently). This increase is followed closely by "Urban Municipal" and "Residential Related," each an approximate increase of 2x over the same period of time (KDOW, 2006b). These statistics are the result of grouping related sub-categories under broad categories to better reflect those significant sources that contribute to impairment of streams in the state.

Individual use support by major river basin is shown in Table 3.3.1-5. This overview of the commonwealth's major river basins shows the greatest percentage of assessed river miles not supporting aquatic life use is found in the Mississippi River Basin. The Big Sandy River has the second greatest percentage of nonsupporting miles followed by the Tradewater River basin, the lower Cumberland River basin and the Ohio River minor tributaries. Those particular basins (Mississippi, Big Sandy, lower Cumberland, Ohio, and Tradewater) are each in areas of intensive land use. The Big Sandy River Basin is one of the most intensive coal producing areas, and the lower Cumberland, Mississippi River, Ohio River minor tributaries and Tradewater River watersheds are in areas of large-scale crop production. Approximately one-third or less of assessed stream miles in the Mississippi and Big Sandy, lower Cumberland and Tradewater basins, and about 40 percent of assessed river miles in the Tradewater River basin, fully support aquatic life use (Figure 3.3.1-1).

The most problematic basins for miles of nonsupporting primary contact recreation are: Tennessee (94.4 percent); Mississippi (94.1 percent); Salt (85.6 percent); Big Sandy (83.5 percent); and Tygarts (82.2 percent) (Table 3.3.1-5). Compared to the 2006 IR, basins with an increase in percentage of assessed miles supporting PCR are the upper Cumberland, Tradewater, Tennessee and lower Cumberland (Figure 3.3.1-2). These basins (with the exception of Big Sandy) have one common denominator: widespread agriculture. The Tennessee and Mississippi basins are intensely managed for agriculture, especially row cropping of soybeans and corn and livestock (primarily cattle) production. Data reported on in the 2004 305(b) report identified the Big Sandy River Basin as having a high percentage of stream miles not supporting PCR primarily because of the high percent of monitored streams where frequent observations were made of straight-pipes from houses that discharged both gray and black water directly into streams. The associated pathogens with the straight-pipe discharge have no effect on the aquatic life as they target warm-blooded hosts. The upper Cumberland River basin has long been a problematic area for pathogen-related water quality concerns. This region is mountainous with dense populations residing in the narrow stream valleys, the only areas suitable for human settlement and commerce. This landform does not have adequate soil types (shallow, rocky) or land available outside floodplains for proper septic treatment. However, a significant change in this region over the past 10 years has been afforded through federal grant dollars becoming available to the area for constructing regional and cluster wastewater treatment facilities. This has successfully moved communities to these treatment facilities and out of floodplain and direct river discharge of untreated sewer water from straight-pipes.

To better contrast the changes of designated use (specifically aquatic life and primary contact recreation) support to the last 305(b) cycle on a basin-scale, Figure 3.3.1-2 illustrates the relative change in designated use support between the two periods. This graph highlights that while this reporting cycle is focused on the Upper Cumberland – 4-Rivers and Green Tradewater BMUs, this report includes a comprehensive statewide update to all BMUs. Those basins that have a positive percent change (increase in full support) considering both DUs are: Green; lower and upper Cumberland; Mississippi; Tennessee; and Tradewater. The greatest decline in assessed DU is the Salt, Licking and Kentucky basins for both DUs (Figure 3.3.1-2). A sure reason for this decline is attributable to intensive TMDL-related monitoring studies in certain 303(d) listed watersheds during this 305(b) reporting cycle.

Table 3.3.1-3. Ranking of causes (pollutants) to Kentucky rivers and streams.

	Cause	Total Size
1.	Sedimentation/Siltation	3,003.67
2.	Fecal coliform + *E. coli* (pathogen indicators)	2,955.75
3.	Nutrient/eutrophication biological indicators	1,525.20
4.	Habitat assessment (streams)*	999.07
5.	Cause unknown	730.35
6.	Organic enrichment (sewage) biological indicators	721.75
7.	Total dissolved solids	704.62
8.	Physical substrate habitat alterations	478.4
9.	Other flow regime alterations*	471.9
10.	Sulfates	288.22
11.	Methylmercury	270.9
12.	pH	269.08
13.	Benthic-macroinvertebrates bioassessment (streams)*	257.60
14.	Turbidity	219.55
15.	Iron	213.40
16.	Particle distribution (embeddedness)	210.50
17.	Specific conductance	150.25
18.	Phosphorus (total)	139.10
19.	Oxygen, dissolved*	118.35
20.	Polychlorinated biphenyls	94.30
21.	PCB in fish tissue	74.40
22.	Total suspended solids (TSS)	73.45
23.	Alteration in stream-side or littoral vegetative covers*	64.80
24.	Chloride	64.75
25.	Nitrate/nitrite (nitrite + nitrate as N)	61.60
25.	Mercury in fish tissue	61.60
27.	Lead	61.40
28.	Aquatic algae*	49.20
29.	Copper	48.10
30.	Dissolved oxygen saturation*	47.20
31.	Nonative fish, shellfish or zooplankton	44.70
32.	Temperature, water*	41.95
33.	Fishes bioassessment (streams)*	41.60
34.	Cadmium	40.20
35.	Ammonia (un-ionized)	33.90
36.	Total Kjeldahl nitrogen (TKN)	14.40
37.	Zinc	11.80
38.	Mercury	11.40
39.	Non-native aquatic plants*	10.10
40.	Nitrogen (total)	9.50
41.	Aquatic plants (macrophytes)*	9.20
42.	Chloride	8.60
43.	BOD, carbonaceous	8.10
44.	Manganese	7.70

Table 3.3.1-3 (cont.). Ranking of causes (pollutants) to Kentucky rivers and streams.

Cause	Total Size
45. Ethylene glycol	6.90
46. Nickel	3.60
47. Chromium (total)	2.60
48. Nitrates	0.20

*Pollution rather than pollutants

Table 3.3.1-4. Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles
Habitat Related (other than hydromodification)	
Loss of riparian habitat	1335.4
Channelization	611.7
Streambank modifications/destabilization	526.2
Site clearance (land development or redevelopment)	222.4
Dredging (e.g. navigation channels)	140.1
Habitat modification – other than hydromodification	14.1
Category total	2,849.9
Agriculture	
Unspecified	1177.7
Non-irrigated crop production	659.7
Crop production (crop land or dry land)	369.3
Managed pasture grazing	189.2
Grazing in riparian or shoreline zones	117.4
Irrigated crop production	84.9
Rangeland grazing	82.5
Animal feeding operations (NPS)	41.6
Manure runoff	21.9
Unrestricted cattle access	15.6
Permitted runoff from confined animal feeding operations (CAFOS)	5.0
Crop production with subsurface drainage	4.5
Dairies (outside milk parlor areas)	3.6
Specialty crop production	3.6
Category total (agriculture)	2,776.5
Urban or Municipal	
Municipal point source discharges	829.7
Discharges from municipal separate storm sewer systems (MS4)	611.7
Urban runoff/storm sewers	360.4
Unspecified urban stormwater	342.6
Sanitary sewer overflows (collection system failures)	240.3
Wet weather discharges (point source and combination of stormwater, SSO or CSO)	50.6
Municipal (urbanized high density area)	77.7

Table 3.3.1-4 (cont.). Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles
Impervious surface/parking lot runoff	25.4
Combined sewer overflows	6.5
Category total	2,544.9
Source Unknown (total)	2,342.5
Mining	
Surface mining	756.0
Subsurface (hardrock) mining	239.7
Coal mining	239.6
Acid mine drainage	131.8
Impacts from abandoned mine lands (inactive)	129.0
Heap-leach extraction mining	78.5
Coal mining (subsurface)	43.2
Mine tailings	21.0
Dredge mining	12.8
Reclamation of inactive mining	7.4
Sand/gravel/rock mining or quarries	6.6
Reclamation of inactive mining	5.9
Category total (mining)	1,671.5
Residential Related	
Package plant or other permitted small flows discharges	443.0
On-site treatment systems (septic systems and similar decentralized systems)	358.7
Sewage discharges in unsewered areas	118.4
Rural (residential areas)	75.8
Unspecified domestic waste	74.3
Residential districts	13.3
Category total	1,083.5
Waste Disposal	
Inappropriate waste disposal	440.8
Landfills	155.3
Septage disposal	8.7
Illegal dumps or other inappropriate waste disposal	4.4
Category total	609.2

Table 3.3.1-4 (cont.). Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles
Miscellaneous	
Other recreational pollution sources	20.0
Wet weather discharges (non-point source)	17.1
Drought-related impacts	14.9
Sources outside state jurisdiction or borders	7.4
Drainage/filling/loss of wetlands	4.8
Off-road vehicles	4.5
Other spill related impacts	2.5
NPS pollution from military base facilities (other than port facilities	2.6
Golf courses	4.8
Category total	527.4
Erosion and Sedimentation	
Post-development erosion and sedimentation	310.9
Channel erosion/incision from upstream hydromodifications	53.2
Sediment resuspension (contaminated sediment)	33.9
Erosion from derelict land (barren land)	15.8
Sediment resuspension (clean sediment)	11.6
Category total	425.4
Silviculture	
Silviculture activities	157.8
Silviculture harvesting	146.6
Woodlot site management	43.6
Woodlot site clearance	37.5
Permitted silvicultural activities	9.0
Silviculture reforestation	6.6
Category total	401.1
Transportation	
Highway/road/bridge runoff (non-construction related)	273.3
Highways, roads, bridges, infrastructure (new construction)	90.3
Airports	1.7
Category total	365.3
Industrial	
Industrial point source discharge	89.7
Industrial/commercial site stormwater discharge (permitted)	79.0
Unpermitted discharge (industrial/commercial wastes)	21.4
Commercial districts (industrial parks)	4.8
Category total	194.9

Table 3.3.1-4 (cont.). Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles
Fuel or Energy Related (other than coal)	
Petroleum/natural gas activities	31.2
Petroleum/natural gas production activities (permitted)	13.7
Category total	44.9
Hydromodifications: dams or impoundments (stream flow)	
Dam or impoundment	22.2
Impacts from hydrostructure flow regulation/modification	14.2
Upstream impoundments (e.g. NRCS structures)	3.6
Category total	40.0

Table 3.3.1-5. Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle.

Basin	Total Assessed	Supporting	Partially Supporting	Not Supporting
Big Sandy				
Aquatic Life	644.4	210.8	274.8	159.7
Fish Consumption	66.6	48.4	15.3	0.0
Primary Contact Rec.	288.1	95.2	21.0	219.5
Secondary Contact Rec.	48.0	0.0	2.5	45.5
Drinking Water	48.1	48.1	0.0	0.0
Green River				
Aquatic Life	**1869.8**	**1075.6**	**440.3**	**354.0**
Fish Consumption	**338.3**	**176.2**	**101.0**	**61.1**
Primary Contact Rec.	**1043.3**	**422.3**	**206.9**	**424.2**
Secondary Contact Rec.	**616.4**	**362.3**	**81.6**	**172.5**
Drinking Water	**274.5**	**255.4**	**0.0**	**0.0**
Kentucky River				
Aquatic Life	1835.9	1053.6	569.3	213.0
Fish Consumption	326.4	176.3	138.9	11.2
Primary Contact Rec.	903.0	208.8	160.6	533.6
Secondary Contact Rec.	428.5	405.6	5.9	17.0
Drinking Water	169.0	169.0	0.0	0.0
Licking River				
Aquatic Life	756.6	390.1	223.6	143.0
Fish Consumption	55.4	55.4	0.0	0.0
Primary Contact Rec.	476.1	149.4	75.5	251.3
Secondary Contact Rec.	155.7	115.1	39.9	0.7
Drinking Water	36.3	36.6	0.0	0.0
Little Sandy				
Aquatic Life	210.7	108.3	85.9	16.5
Fish Consumption	25.6	25.6	0.0	0.0
Primary Contact Rec.	62.3	60.6	0.0	1.7
Secondary Contact Rec.	0.0	0.0	0.0	0.0
Drinking Water	14.3	14.3	0.0	0.0

Table 3.3.1-5 (cont.). Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle.

Basin	Total Assessed	Supporting	Partially Supporting	Not Supporting
Lower Cumberland				
Aquatic Life	**354.9**	**135.1**	**126.8**	**90.4**
Fish Consumption	**48.8**	**39.4**	**9.4**	**0.0**
Primary Contact Rec.	**179.2**	**50.2**	**38.6**	**93.0**
Secondary Contact Rec.	**2.4**	**0.0**	**2.4**	**0.0**
Drinking Water	**33.2**	**33.2**	**0.0**	**0.0**
Mississippi River				
Aquatic Life	**275.7**	**57.6**	**117.4**	**100.7**
Fish Consumption	**93.9**	**93.9**	**0.0**	**0.0**
Primary Contact Rec.	**63.2**	**3.7**	**12.2**	**47.25**
Secondary Contact Rec.	**5.4**	**0.0**	**0.0**	**5.4**
Drinking Water	**0.0**	**0.0**	**0.0**	**0.0**
Ohio River (minor tribs)				
Aquatic Life	**489.7**	**203.1**	**144.5**	**142.2**
Fish Consumption	**29.6**	**22.4**	**0.0**	**7.2**
Primary Contact Rec.	**159.1**	**60.3**	**12.6**	**86.2**
Secondary Contact Rec.	**79.4**	**60.9**	**0.0**	**18.5**
Drinking Water	**0.0**	**0.0**	**0.0**	**0.0**
Salt River				
Aquatic Life	1070.6	664.2	250.3	156.1
Fish Consumption	73.3	47.0	14.3	12.0
Primary Contact Rec.	471.6	67.8	119.0	284.8
Secondary Contact Rec.	247.2	228.0	0.0	19.2
Drinking Water	5.2	5.2	0.0	0.0
Tennessee River				
Aquatic Life	**295.1**	**143.5**	**98.9**	**52.8**
Fish Consumption	**26.4**	**15.1**	**11.3**	**0.0**
Primary Contact Rec.	**109.7**	**6.2**	**39.0**	**64.5**
Secondary Contact Rec.	**0.0**	**0.0**	**0.0**	**53.6**
Drinking Water	**0.0**	**0.0**	**0.0**	**0.0**

Table 3.3.1-5 (cont.). Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle

Basin	Total Assessed	Supporting	Partially Supporting	Not Supporting
Tradewater River				
Aquatic Life	**292.8**	**110.4**	**71.6**	**110.8**
Fish Consumption	**0.0**	**0.0**	**0.0**	**0.0**
Primary Contact Rec.	**145.9**	**36.4**	**0.0**	**109.5**
Secondary Contact Rec.	**105.4**	**34.8**	**17.0**	**53.6**
Drinking Water	**0.0**	**25.8**	**0.0**	**0.0**
Tygarts Creek				
Aquatic Life	113.3	96.2	16.0	1.1
Fish Consumption	56.3	10.6	0.0	45.7
Primary Contact Rec.	55.6	9.9	0.0	45.7
Secondary Contact Rec.	0.0	0.0	0.0	0.0
Drinking Water	10.6	10.6		0.0
Upper Cumberland				
Aquatic Life	**1320.3**	**835.2**	**254.3**	**230.9**
Fish Consumption	**104.55**	**91.9**	**12.4**	**0.0**
Primary Contact Rec.	**535.7**	**184.9**	**51.6**	**299.2**
Secondary Contact Rec.	**178.6**	**88.6**	**4.0**	**86.0**
Drinking Water	**86.5**	**86.5**	**0.0**	**0.0**

Figure 3.3.1-1. Aquatic life and primary (swimming) contact recreation use support by major river basins in Kentucky.

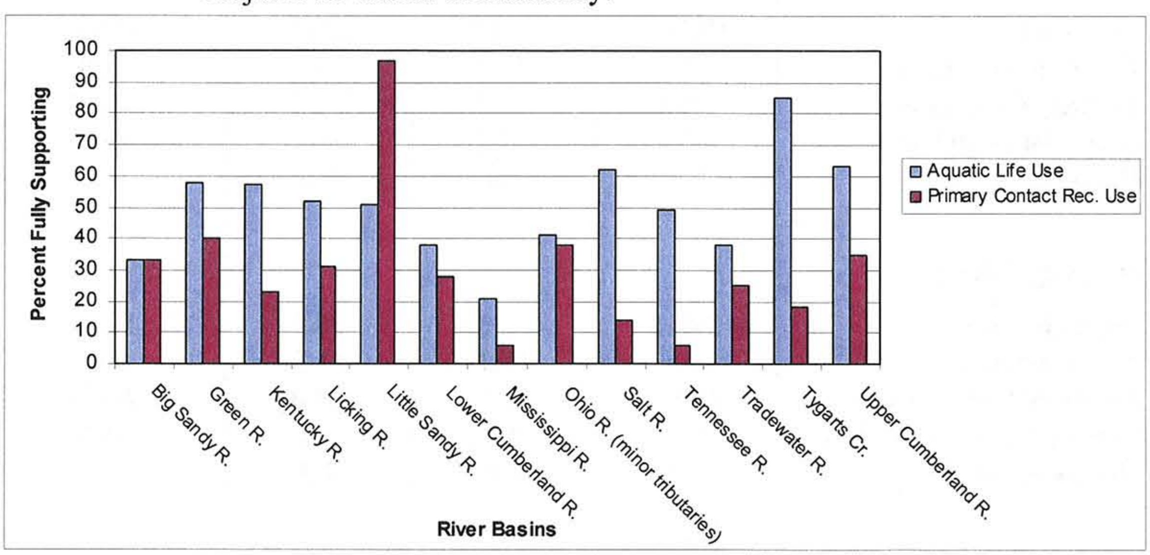
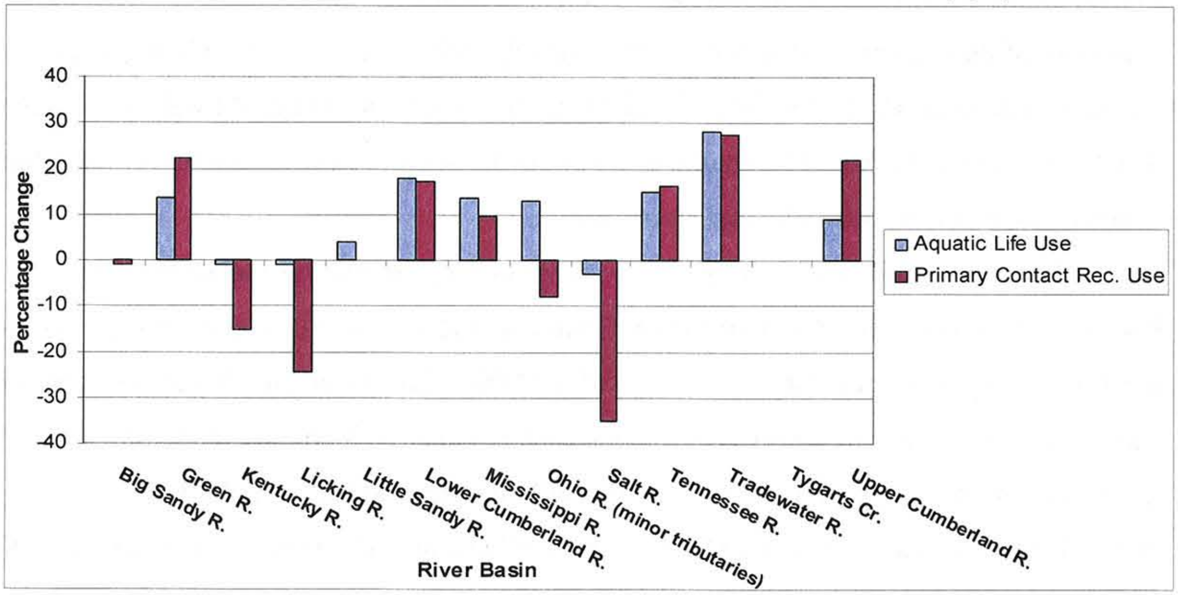


Figure 3.3.1-2. Percent change regarding full support level (based on stream miles) in major Kentucky river basins between 2006 and 2008 305(b) cycle.



3.3.2 Use Assessment Results for 305(b) Reporting Cycle 2007 and 2008

Upper Cumberland – 4-Rivers BMU. This BMU is divided in two primary basins, the upper Cumberland River in southeast and south Kentucky and 4-Rivers in south-central and west Kentucky. The Cumberland River basin rises in southeast Kentucky near the Kentucky – Virginia border in Letcher County on the southeast slope of Pine Mountain. It drains much of southeast Kentucky, enters Tennessee below Burkesville, Kentucky, then re-enters the commonwealth in west Kentucky just west of Fort Campbell military base, discharging (30,441 cubic feet per second) into the Ohio River near Smithland after flowing 687 miles from the source waters. The entire drainage basin is 18,081 square miles and drains parts of Kentucky and Tennessee. The Cumberland and Tennessee rivers parallel each other, and both discharge into the Ohio River within nine linear miles of each other.

The diverse physiographic characteristics of these two portions of the BMU have influenced the ecoregions and diversity of plants and animals immensely. These two regions of the state are characterized by low mountains (Black Mountain elevation 4,145 ft.) and high plateau in the upper Cumberland River watershed transitioning to cypress swamps, bottomland hardwoods and coastal plain regions in southwest and west Kentucky where these rivers discharge, draining a region bound roughly from north to south from southwest New York to north Alabama and east to the southern Appalachian provence of

Virginia. The upper Cumberland River basin drains approximately 6,250 square miles and overall drains approximately 18,000 square miles in Kentucky and Tennessee. The mainstem of the Cumberland River is approximately 700 miles (1,127 km) long. Major tributaries (in Kentucky) include: 1) South Fork; 2) Little South Fork; 3) Rockcastle River; and 4) Red River. Principal Kentucky cities in the basin are: Harlan; Middlesboro; Corbin; London Somerset; Burkesville; and Hopkinsville.

The Mississippi, Ohio and Tennessee rivers complete that portion of this BMU known as "4-Rivers" (including the lower Cumberand River basin). These are large rivers; the Tennessee River is the largest tributary of the Ohio. The Tennessee River drains 40,876 square miles covering portions of seven southeastern states as it courses along 652 river miles draining physiographic regions as diverse as the Blue Ridge Mountains to coastal plain where it discharges into the Ohio River near Paducah. The Ohio River discharges into the Mississippi River near Cairo, Illinois at river mile 981. It is the largest tributary of the Mississippi with an average discharge volume of 281,000 cubic feet per second draining 189,422 square miles of watershed extending from New York to Alabama. This river represents an aquatic climatic transition zone as it courses along the periphery of the humid subtropical and humid continental climatic zones integrating fauna and flora of both zones. The Mississippi River is the largest river in the US, both in system length (2,320 miles) and drainage area (1,151,000 square miles). It flows along Kentucky's western border with Missouri for 68 miles.

Following are highlights of data and statistical analyses related to the two BMUs of emphasis for this particular 305(b) cycle, both targeted and probability-based water quality and biosurveys to determine aquatic life use and other monitoring results as they relate to each of the four designated uses. Appendix 3.A contains a complete table of monitoring results for each specific water body and segment as related to streams and rivers. This table contains all significant information in abbreviated form providing a quick reference for each assessed water body or segment, the level of support, pollutants, related and sources. For refinement to the degree of use support, nonsupport miles were further subdivided into partial support and nonsupport categories based on physicochemical, MBI or KIBI scores and are reflected in this 305(b) assessment. This assists KDOW and the public in recognizing the relative degree of potential pollutant and habitat impacts on each system.

Appendix 3.B contains reach indexing maps of these assessment results based on NHD 1:24,000 scale data for this BMU.

Causes, Sources and Land Uses. Causes (pollutants) and sources of pollutants or pollution particular to the Upper Cumberland – 4 Rivers BMU are listed in Table 3.3.2-1. The upper Cumberland and lower Cumberland River have similar causes and sources of impairment even though the two "basins" drain different physiographic provinces and varied drainage land uses particular to each portion of the basin. These physiographic regions between the upper and lower basins have differing landscape and geologic characteristics. The upper basin drains approximately 5,200 square miles within Kentucky, primarily in the Cumberland Plateau and Mountains physiographic region, which encompasses about 10,500 square miles. This region is a highly dissected plateau with steep slopes and narrow sinuous valleys. The geologic stratigraphy is composed mainly of sandstone, shale and coal. Thus, the pH is slightly lower in this region (decidedly so on the south slope of Pine Mountain) as compared to most of the state with less buffering capacity of those waters. The primary land uses in this region are deep and surface mineral (coal) extraction, forest-related activities and small-scale livestock grazing, with small cities dotting the landscape in the valleys. The limestone strata are primarily in that portion of this basin that flows through the eastern Pennyroyal. This landscape is rugged, as it is the foothills of the Cumberland Plateau, having fertile broad bottomland in the river valleys where most of the agriculture is practiced. The terrain has significant karst with sinkholes, caves and underlying streams that increases the sensitivity of the watersheds to surface uses. In landscapes of significant resource extraction, sedimentation and dissolved solids (specific conductance) and pH are often the prevailing pollutants as vegetation is removed and bare soil and geologic strata are exposed. Elevated total dissolved solids are a particular concern in these waters that often have low buffering capacity and are naturally infertile. In areas of significant land disturbance and exposure of geologic strata, an abundance of ions from minerals such as iron, magnesium and calcium are liberated into the water column, along with other metals. These three impairments of issue within the BMU, along with related habitat disruption or loss, account for 487 miles of the 843 miles (58 percent) impacted by the top five pollutants in the upper Cumberland basin (Table 3.3.2-1). The mentioned significant land uses in this basin are reflected in identified sources of the pollutants. The top three sources are loss of riparian habitat, surface mining and legacy coal extraction; however, the largest portion of pollutant-sources identified went unrecognized and thus is listed as "source unknown" (38 percent) (Table 3.3.2-1).

The lower Cumberland basin is composed of one HUC (05130205) with a drainage area of 1,351 square miles. This watershed is located in the western Pennyroyal Physiographic Region. The landscape is of similar type, although the topography is less rugged and mean elevations are lower with less karstic conditions. Land use is primarily agriculture, with a significant acreage cultivated for corn and soybean production; livestock grazing occurs to a lesser degree. Recreation related uses are associated with Lake Barkley, a large COE reservoir created by damming the mainstem Cumberland River, and adjacent Land Between the Lakes recreation area (US Forest Service). This reservoir located in west Kentucky and Tennessee has 57,920 total water-surface acres with 42,780 water-surface acres in Kentucky. The largest city in this basin is Hopkinsville, with nearby Fort Campbell Military Base to the south. Identified pollutants for this basin are primarily pathogens (bacteria), sedimentation/siltation and nutrient/eutrophication biological indicators, constituting 73 percent of affected stream mileage (Table 3.3.2-1). Primary sources of these pollutants are identified as agriculture, source unknown and crop production, which represents 73 percent of sources identified per affected stream mile (Table 3.3.2-1).

The remainder of this BMU covers the Jackson Purchase region, an area bound on the west by the Mississippi River, north by the Ohio River and east by the Tennessee River. This region is alluvial with loess soils deposited from glaciated areas to the north. Geologically the region is part of the Mississippi River delta, associated with the Gulf Coastal Plain of the southeast US that extends from the mouth of the Mississippi River up to the mouth of the Ohio River. The primary land use on this broad floodplain is row cropping, primarily corn and soybeans. Much of the natural systems of this area have been altered by this intensive agricultural use, particularly the draining of swamps and bottomland hardwoods for crop production.

Table 3.3.2-1. Number of assessed river miles of the top five causes and sources in the major river basins within the 4-Rivers BMU and Green-Tradewater Rivers BMU.

River Basin	Miles		Miles
Lower Cumberland			
Causes		*Sources*	
Pathogens	129.0	Agriculture	320.4
Sedimentation/Siltation	124.1	Source Unknown	197.6
Nutrient/Eutrophication Biological Indicators	108.3	Crop Production (Crop Land or Dry Land)	170.2
Cause Unknown	77.7	Municipal Point Source Discharges	138.5
Organic Enrichment (Sewage) Biological Indicators	53.0	Non-irrigated Crop Production	117.6
Mississippi River			
Sedimentation/Siltation	177.35	Channelization	251.7
Other Flow Regime Alterations	76.8	Loss of Riparian Habitat	239.4
Pathogens	64.95	Agriculture	155.8
Nutrient/Eutrophication Biological Indicators	51.65	Source Unknown	137.4
Habitat Assessment (Streams)	41.2	Non-irrigated Crop Production	132.9
Tennessee River			
Pathogens	103.5	Source Unknown	207.2
Cause Unknown	78.6	Agriculture	144.45
Sedimentation/Siltation	48.0	Channelization	64.5
Nutrient/Eutrophication Biological Indicators	37.6	Non-irrigated Crop Production	63.6
Iron	24.0	Crop Production (Crop or Dry Land)	58.8
Upper Cumberland			
Sedimentation/Siltation	307.55	Source Unknown	322.95
Pathogens	271.0	Loss of Riparian Habitat	299.95
pH	89.98	Surface Mining	239.1
Specific Conductance	89.25	Legacy Coal Extraction	164.7
Nutrient/Eutrophication Biological Indicators	85.35	Agriculture	141.85
Ohio River Minor Tributaries (4-Rivers & Green-Tradewater BMU)			

Table 3.3.2-1. Number of assessed river miles of the top five causes and sources in the major river basins within the 4-Rivers BMU and Green-Tradewater Rivers BMU.

River Basin	Miles		Miles
Ohio River Minor Tributaries (4-Rivers & Green-Tradewater BMU			
Causes		*Sources*	
Nutrient/Eutrophication Biological Indicators	86.2	Loss of Riparian Habitat	136.4
Sedimentation/Siltation	77.6	Agriculture	103.5
Pathogens	68.5	Industrial Point Source Discharges	96.0
Physical Substrate Habitat Alteration	56.4	Source Unknown	94.6
Cause Unknown	44.6	Inappropriate Waste Disposal	88.8
Green River			
Pathogens	554.65	Source Unknown	718.5
Sedimentation/Siltation	485.45	Loss of Riparian Habitat	556.3
Physical Substrate Habitat Alteration	282.6	Agriculture	415.85
Nutrient/Eutrophication Biological Indicators	196.7	Channelization	391.6
Cause Unknown	176.55	Non-irrigated Crop Production	334.3
Tradewater River			
Sedimentation/Siltation	108.8	Channelization	169.7
Pathogens	81.65	Source Unknown	161.5
Nutrient/Eutrophication Biological Indicators	53.9	Loss of Riparian Habitat	155.7
Other Flow Regime Alterations	49.3	Surface Mining	144.7
Physical Substrate Habitat Alteration	45.5	Non-irrigated Crop Production	102.1

The Tennessee River drainage in Kentucky is an area identified by two eight-digit HUCs, (06040005 and 06040006), with a total drainage of 1,041 square miles. The largest tributary in this portion of the Tennessee River is the Clarks River, which discharges to the Tennessee River four miles above its confluence with the Ohio River.

The Ohio River minor tributaries are identified by one eight-digit HUC (05140206) and drains 326 square miles. The two principle streams in this drainage are Massac and

Humphrey creeks; the greatest linear distance from the southern watershed boundary to the Ohio River is about 17 miles.

The Mississippi River drainage is bound by three eight-digit HUCs, 08010100, 08010201 and 08010202 encompassing 1,203 square miles. The Obion and Mayfield creeks watersheds are the principal drainages directly discharging into the Mississippi River in the Jackson Purchase (of course excluding the Ohio River).

The most significant pollutant in this region of great rivers is "sediments/siltation," accounting for 359 affected stream miles. Pathogen indicators impact 237 stream miles, and nutrients also are identified as a significant pollutant in this basin, with 175 stream miles affected. Significant sources of these pollutants are agricultural sources (596 stream miles), loss of riparian habitat (376 stream miles) and "channelization" (canalization) (316 stream miles). Those pollutant-sources make sense from a relational association. Sediment/siltation, pathogens and nutrients are closely associated; where one is prevalent, particularly sedimentation/siltation, the others are found also, and the loss of riparian habitat nearly paralleling sedimentation/siltation in this basin. This pollutant affects more stream miles than any other in this BMU, as well as Kentucky and the nation. Soils, particularly clays, have high negative charges and thus adsorb cations readily, and these constituents are then transported to receiving streams where habitat buffering provided by riparian vegetation has been lost. As wetlands were ditched and drained, the delayed result was streams and ditches that filled in with sediments, resulting in substantial flooding and erosion. The result is an ongoing cycle of filling and dredging of these stream channels. Soils in this region are particularly susceptible to erosion since they are of particularly fine material (sands and silts) from wind-carried loess.

Upper Cumberland River Basin

Targeted Monitoring: Aquatic Life Use. The targeted monitoring effort resulted in 835 miles of 1320 miles (63 percent) assessed for aquatic life in the upper Cumberland River basin as fully supporting (Table 3.3.2-3). This use may be considered the most sensitive to impairments of all uses that apply to streams and lakes because all ecological elements of the aquatic environment must be of a sufficient level of integrity and quality to support aquatic communities dependent on the resource, (both water quality and in-stream and out-of-stream habitat). While the majority of miles assessed at targeted monitoring locations for aquatic life were assessed based on biological monitoring, some of those miles were assessed using water physicochemical data at long-term and rotating watershed locations.

One additional stream in the Cumberland River basin is proposed as a RR stream in the 2008 Triennial Review (Table 3.1.42). It should be noted as each cycle phase is repeated, a fewer number of stream miles will likely be added to the reference reach list since there has been a concerted effort to locate all least impacted streams. However, identifying new stream segments as exceptional (401 KAR 5:030) will be a part of KDOW's overall monitoring strategy.

Targeted Monitoring: Fish Tissue. Fish tissue samples were analyzed for mercury and PCB contamination in the upper Cumberland River basin. Of the 105 miles assessed for fish consumption, 92 (about 88 percent) were in full support (Table 3.3.1-5). Approximately 13 miles (12 percent) were not fully supporting this use.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of *E. coli* or fecal coliform colonies to assess this use support. There were 536 river miles assessed in the upper Cumberland River basin (Table 3.3.1-5). Of those river miles, 185 (35 percent) (Figure 3.3.1-1) were fully supporting and 351 miles (65 percent) were partially or not supporting (Table 3.3.1-5). The upper Cumberland River basin (above Pineville) has had a long-standing swimming advisory based on pathogens that remains in effect as of this cycle phase (see section 3.3.1). There were two primary issues related to this high concentration of fecal coliform colonies: municipal point source discharges, with a number of bypasses at wastewater treatment facilities, and straight-pipes discharging untreated household wastewater. Both sources can be tied to topography of the region, which is mountainous with narrow valleys associated with stream and river courses. These valleys provide much of the suitable land where housing can exist with reasonable access. However, available land to construct septic systems with needed lateral lines typically does not exist. The soils in these bottomlands often are poorly drained, further restricting proper on-site treatment in rural areas. A related scenario exists for the wastewater treatment facilities, which often are built in the flood zone of rivers, as these areas provide the limited sites to seat a facility. There is now a concerted effort in this region to construct regional wastewater treatment plants; this is being realized through federal grant moneys being made available to this economically depressed region.

Targeted Monitoring: Domestic Water Supply. All miles (86.5) assessed in the upper Cumberland River basin were fully supporting this use (Table 3.3.1-5).

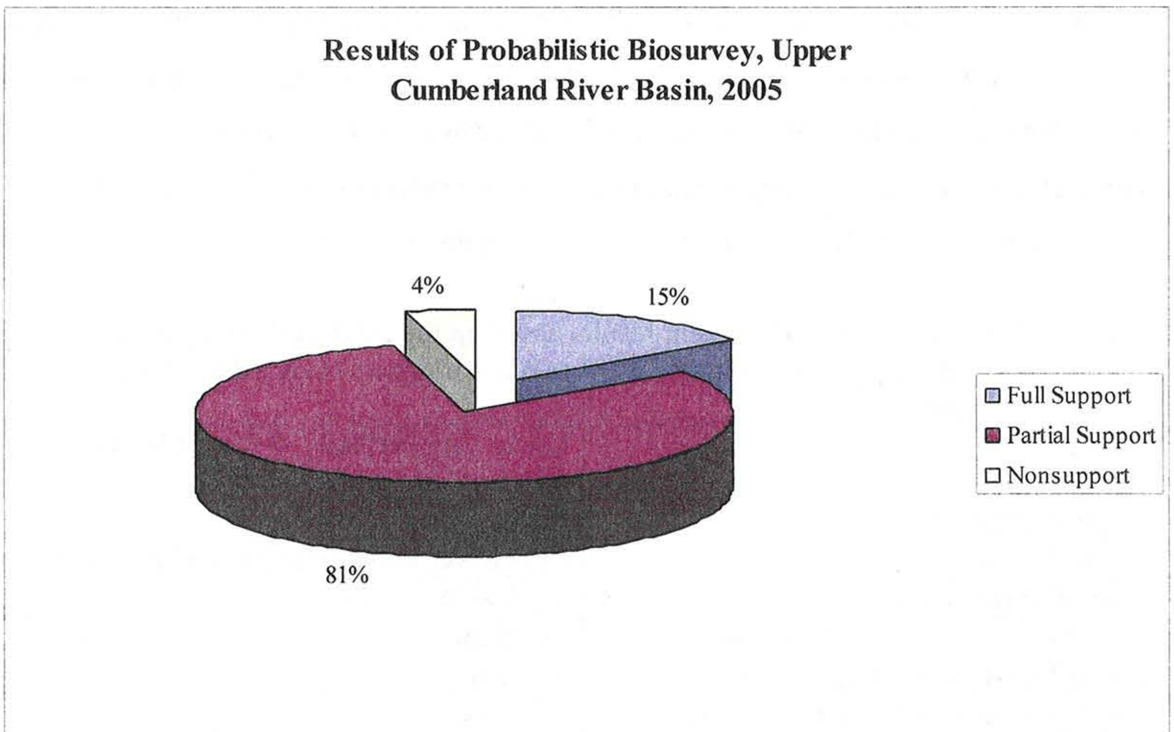
Probability Biosurvey of BMU. A biosurvey of the upper Cumberland River basin was performed according to EMAP and Kentucky SOP protocol (Methods for Assessing Biological Integrity Of Surface Waters in Kentucky), 2006. Because of significant refinement and calibration to KDOW's MBI, comparisons to the 2000 results were problematic and not comparable; therefore, drawing trend information comparisons between the two monitoring years was not possible. As Table 3.3.2-3 conveys, out of 5,599 miles of target stream resources, 4,361 miles were represented in the probability analysis. Once the probability data were extrapolated, 653 miles or 15 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 3531 miles or 81 percent of wadeable streams were partially supporting, and four percent (177 miles) were not supporting the aquatic life use (Table 3.3.2-3 and Figure 3.3.2-1).

Table 3.3.2-2. Aquatic use attainment results based on the 2003 probability biosurvey of the upper Cumberland River basin (all numbers rounded to nearest integer).

Project ID	Upper Cumberland – 4-Rivers BMU (Upper Cumberland River Basin)
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Defined Stream Population	6,890 mi
Size of Non-Defined Population	2,529 mi
Size of Defined Sampled Population	4,361 mi
Designated Use	Aquatic Life
Attaining Full Use Support	653 mi
Not Attaining Full Use (partial support)	3,531 mi
Not Attaining Full Use (nonsupport)	177
Indicator	Biology (Macroinvertebrates)
Assessment Date	2005
Precision	90% at 95% Confidence Level

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results differed in the upper Cumberland River basin (Table 3.3.2-3). In this basin, the reference reach and other target-focused programs identified 280 miles, or 21 percent of those streams monitored and assessed, as candidates for and RR waters (Tables 3.1.4-1 and 2). This has been the focus of targeted biomonitoring since the late 1990s, and it became the significant focus with the inception of the rotating BMU strategy in 1998. However, during the 2005 water-year the focus shifted toward concentrating on water bodies and segments 303(d)-listed. In the BMU-wide assessment data, including all monitoring efforts from 2005 and prior targeted monitoring results

Figure 3.3.2-1. Proportions of aquatic life use support in the Upper Cumberland River basin based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.



account for 1320 miles of assessed waters and include 835 miles (63 percent) full support for aquatic life use, 254 miles (19 percent) partial support and 231 (18 percent) nonsupport (Table 3.3.2-3). In those numbers is significant stream mileage where assessment results are based solely on physicochemical data. The number of water bodies assessed on these data alone are small, but this monitoring occurs on large streams of Strahler order 6 and greater. The streams with only physicochemical data are generally large (> 5th order) rivers that provide a considerable amount of dilution, and the chances are small of collecting water at the time any one particular pollutant passes with a concentration high enough to exceed water quality criteria. Of those stream miles assessed with only physicochemical data none in this basin were determined to be less than full support. Probability monitoring design selects an equitable number of Strahler order 1 and 2 streams, in addition to Strahler order 3 - 5. These smaller watersheds show stress in biological communities to relatively smaller-scale perturbations than the large watersheds, which can often assimilate more disturbances relative to watershed size. Also, the approach to locating sample locations differs significantly between the two biological programs. The targeted stations are located in the best available stream reach regardless of the monitoring program (Sections 3.1.1-3), whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly select locations throughout the study area (BMU) without regard to prevailing in-stream habitat.

Table 3.3.2-3. Comparison of probability and targeted monitoring results for aquatic life use in the upper Cumberland River basin.

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	653	835	3531	254	177	231
Percent	15	63	81	19	4	18

4-Rivers Basin (Lower Cumberland, Lower Ohio [minor tributaries], Mississippi and Tennessee)

Targeted Monitoring: Aquatic Life Use. The targeted monitoring effort resulted in 539 miles (of 1,415 miles) (38 percent) assessed for aquatic life use in the 4-Rivers basins as fully supporting (Tables 3.3.2-5). In this region of intensive agriculture and soil type, determining the support level of aquatic life use will often be inconclusive or may be difficult with less than biological community structure evaluation. This due is to the fact that in large areas with row cropping as dominant land use, the results of chemical monitoring are gratly affected by the timing of agricultural land management. Pesticide and herbicide applications (under proper, prudent use) often are only applied after pest management data signal the damage is approaching economic threshold where chemical treatment is cost-effective. Thus, if chemical monitoring is not timed to coincide with these agricultural practices, the effects will go unnoticed in conventional physicochemical monitoring. While the majority of miles assessed at targeted monitoring locations for aquatic life were assessed based on biological monitoring, some of those miles were assessed using physicochemical data at long-term and rotating watershed locations. Most of these stations are large watersheds of greater than 5th-Strahler order; determining appropriate biological monitoring indicators and protocol are under development on a national level.

Fish Tissue. Fish tissue samples were analyzed for mercury and PCB contamination in the 4-Rivers basins. This designated use was assessed on 199 stream miles; of those miles assessed, 86 percent were full support and 14 percent were less than full support (Table 3.3.1-5). Of the three basins considered in this portion of the BMU, the only basin with less than 75 percent not fully supporting this use was the Tennessee River basin with a 57 percent (15 miles out of 26 miles) full support level.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of fecal coliform colonies to assess this use support. There were 511 river miles assessed in these basins for PCR (Table 3.3.1-5). Of those river miles, 120 (24 percent) (Figure 3.3.1-1) were fully supporting and 391 miles (76 percent) were partially or not supporting this use. The majority of those stream miles not supporting this designated use were located in the Mississippi or Tennessee river basins. While all basins in this region are in predominantly agricultural production, these two particular basins comprise the Jackson Purchase region which is intensively managed for this single industry. There were two primary sources related to this high concentration of bacteria colonies, agriculture and loss of riparian habitat. Where agriculture is an intensive land use, the loss of protective riparian vegetation (habitat) is most prevalent. Through efforts of the KDOW and federal agencies, funding (cost share and grants) and education for riparian zone-specific protection is ongoing, although there is much work left to do.

Targeted Monitoring: Domestic Water Supply. All miles assessed in the 4-Rivers basins fully supported this use (Table 3.3.1-5).

Probability Biosurvey of 4-Rivers Basins. The 4-Rivers basins were sampled according to EMAP and Kentucky SOP (Methods for Assessing Biological Integrity Of Surface Waters in Kentucky), 2006. Because of significant refinement and calibration to KDOW's MBI, comparisons to the 2000 results were problematic and not comparable; therefore, drawing trend information comparisons between the two monitoring years was not possible. As Table 3.3.2-4 conveys, out of 7,443 miles of target stream resources, 5,600 miles were represented in the probability biosurvey and analysis. The target stream mileage population (1,843 miles) is greater than the sampled target population since not all miles in a study area can be accessed for many reasons, most commonly a result of miss-mapped or identified features, but also less commonly due to physical risk in accessing certain areas. Once the probability data were extrapolated, 254 miles or 17 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 5,346 miles, 83 percent of wadeable streams were not fully supporting that use (Table 3.3.2-5 and Figure 3.3.2-2).

Table 3.3.2-4. Aquatic life use attainment results based on the 2005 probability biosurvey of the 4-Rivers basins (numbers rounded to nearest integer).

Project ID	4-Rivers Basins Probability Survey
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Defined Population	7,443 mi
Size of Non-Defined Population	1,843 mi
Size of Defined Sampled Population	5,600 mi
Designated Use	Aquatic Life
Attaining Full Use Support	565 mi
Not Attaining Full Use (nonsupport)	2,630 mi
Not Attaining Full Use (partial support)	2,404 mi
Indicator	Biology (Macroinvertebrates)
Assessment Date	2005
Precision	90% at 95% Confidence Level

Figure 3.3.2-2. Proportions of aquatic life use support in the 4-Rivers basins, 2005, based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.

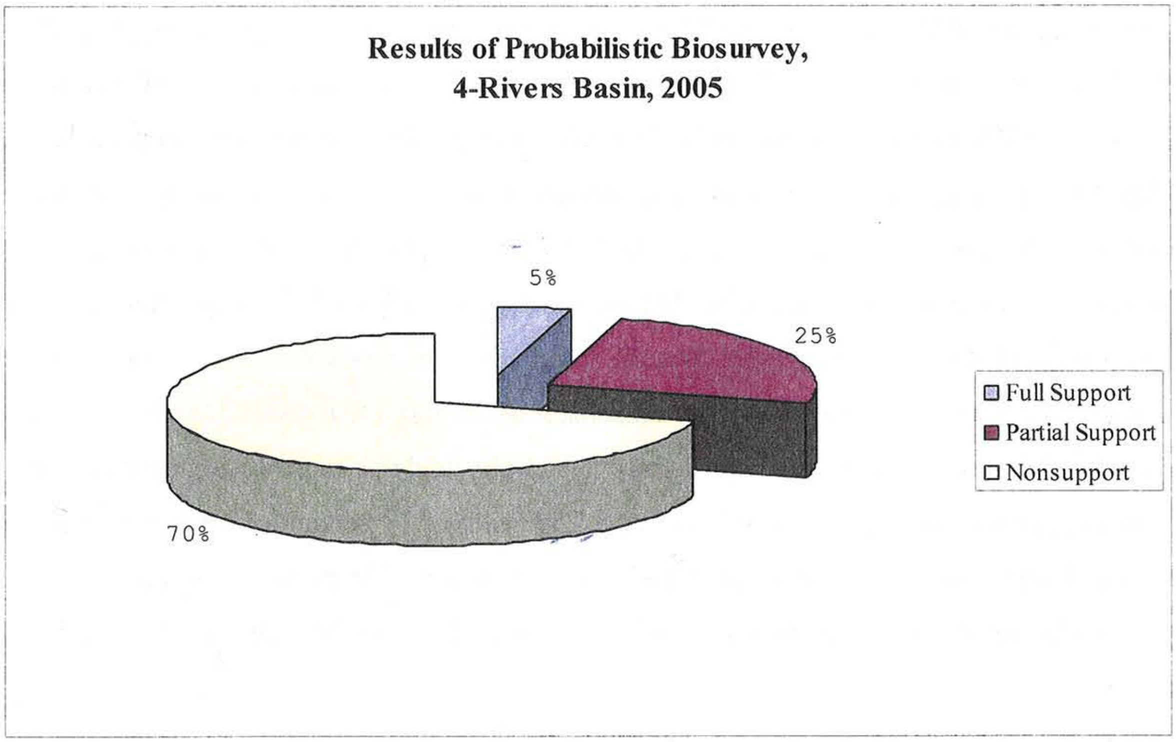


Table 3.3.2-5. Comparison of probabilistic and targeted monitoring results for aquatic life use in the 4-Rivers basins.

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	254	539	1389	488	3,957	386
Percent	17	38	57	35	26	27

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results compare more closely in the 4-Rivers basins (Table 3.3.2-5) than in the upper Cumberland River basin. In the region identifying RR-quality waters has been difficult given the intensively managed land. There have been 98 miles (seven percent) of targeted streams identified as RR quality; a small fraction meeting those criteria as compared to many basins in the commonwealth (three times fewer stream miles as compared to the Upper Cumberland River basin) (Table 3.1.4-1). During this second cycle, the BMU monitoring strategy has focused more in watersheds with 303(d)-listed waters for purposes of TMDL development. This focus is beginning to bring the nonsupport stream mile curves assessed between the targeted and probability programs closer as the nonsupport miles increases in the targeted monitoring program. In the BMU-wide assessment data from all monitoring efforts through 2005, targeted monitoring results account for 1,413 miles of assessed waters and includes 539 miles (38 percent) full support of aquatic life use, 488 miles (35 percent) partial support and 386 (27 percent) nonsupport (Table 3.3.2-5). This contrasts with only 17 percent of miles fully supporting in the probabilistic monitoring, which statistically is applied to the entire representative defined sample population, while the targeted assessments include cumulative results from previous years, with a bias toward those RR waters. Even with this bias, the relative similarity between results of the two monitoring approaches indicates the overall poor condition of aquatic habitat in these basins. This is a strong reflection of the wide-scale manipulation of the aquatic and stream-side environment in this region.

With all basins, significant stream mileage exists where assessment results are based solely on physicochemical data. The number of water bodies assessed on these data alone are small, but this monitoring occurs on large streams of Strahler order 6 and greater. These large watersheds (by volume) provide a considerable amount of dilution, and the chances are small of collecting water at the time any one particular pollutant passes with a concentration high enough to exceed water quality criteria. Of those stream miles assessed with only physicochemical data, few were determined to be less than full support, although the 4-Rivers basins did have a higher number of stream miles not fully supporting based on results from this program. This was due to the geology, resultant water chemistry (soft, lower buffered and pH normally less than 7.0 SU), particularly with regard to metals, and associated land uses.

Probability monitoring design selects an equitable number of Strahler order 1 and 2 streams, in addition to Strahler order 3 - 5. These smaller watersheds show stress in biological communities to relatively smaller-scale perturbations than the large watersheds, which can often assimilate more disturbances relative to watershed size. Also, the approach to locating sample sites differs significantly between the two biological programs. The targeted stations are located in the best available stream reach regardless of the monitoring program (Sections 3.1.1-3), whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly selected locations throughout the study area (BMU) without regard to prevailing in-stream habitat.

Green – Tradewater Rivers BMU. Two major river systems are combined to form this BMU (Figure 2.2-1). The Green River is the largest intrastate river system (i.e. mainstem of the river is wholly in Kentucky) in the commonwealth, draining an area of 9,807 square miles, including a small area of north-middle Tennessee. This river originates in Lincoln County on the southwest face of Hall's Gap in south-central Kentucky. It flows for 300 miles after which it discharges into the Ohio River. There are four significant tributaries along this course: Nolin River; Barren River; Rough River and Pond River. The Green River basin flows through the Pennyroyal and Shawnee Hills (Western Coal Field) physiographic regions. A good portion of the basin associated with the mid-river valley is significantly karstic, with Mammoth Cave the prominent feature of this vast cave network. This feature makes the Green River basin particularly susceptible to land uses since the Swiss-cheese latticework of underground channels results in surface water runoff quickly reaching groundwater with little opportunity for natural filtration that would occur in non-karst geology. These subterranean streams often form gaining streams discharging into surface water flows. In 1969 the COE created an 8,200 acre flood-control reservoir on the Green River mainstem, Green River Lake, which is located in the upper portion of the basin in south-central Kentucky. Most of the Pennyroyal (all but the southeastern quarter) is drained by this river system and is rolling terrain with associated broad, fertile bottomlands.

The Shawnee Hills is a region of hilly upland of relatively high relief and contains many swamps and bottomland hardwoods due to the poorly drained valleys. This physiographic region is often referred to the Western Coalfield due to the significant coal deposits. At one time Muhlenberg County was the largest coal producing county in the nation, and the lower Green River was an important shipping corridor for this mined resource; the river can be navigated by commercial barge traffic up to lock and dam #3 (river mile 108.5) .

The Tradewater River drains the western portion of the Shawnee Hills region and originates in northern Christian County, about eight miles north of Hopkinsville. The Tradewater is a low-gradient stream flowing through swampland characterized by cypress trees. This river is a tributary of the Ohio River. It is 132 miles long and drains 932 square miles, discharging into the Ohio River approximately five miles southwest of Sturgis. This portion of the physiographic region is similar to that described in the above paragraph. As with the lower Green River basin, the Tradewater River basin has had much surface coal mining, especially during the 1970s and 1980s.

Causes, Sources and Land Uses. The top five causes (pollutants) and their sources in this BMU, identified for each river basin, are shown in Table 3.3.2-1. As one might expect, these two basins are mirror images of each other with respect to pollutants and sources (Table 3.3.2-1). Pathogen-indicating bacteria and sedimentation/siltation are the two most prevalent pollutants; however, pathogen indicators are pollutants only with regard to PCR and SCR uses. Pathogen causes affect 33 percent of assessed miles (555) in the Green River basin and 24 percent (82 miles) in the Tradewater River basin. Similarly, sedimentation/siltation associated with aquatic life habitat use affects 29 percent (486 miles) and 32 percent (109 miles) of assessed stream miles in the Green and Tradewater rivers basins, respectively. The leading sources of these pollutants strongly correlate to extensive agricultural and mining land uses. As with the 4-Rivers basins, agricultural, loss of riparian habitat and canalization (channelization) account for 67 percent of identified causes (pollutants and pollution), affecting 2,126 miles combined. Those additional causes associated with aquatic life habitat commonly occur in areas associated with agriculture and mining, particularly the nutrient/eutrophication, sedimentation/siltation and physical substrate habitat alteration. One of the most detrimental effects of stream habitat integrity affecting aquatic life use support level is the source "Loss of Riparian Habitat" identified as one of the top three most common source of impairment in the BMU (Table 3.3.2-1). This is a source that is often a direct result of other land use-related sources of impairments such as agriculture and resource extraction, and it is a major contributing factor to sedimentation and siltation.

Targeted Monitoring: Aquatic Life Use. The targeted monitoring effort resulted in 1,389 stream miles out of 2653 miles (52 percent) assessed for aquatic life use in the Green – Tradewater River BMU fully supports this use (Tables 3.3.2-7). This is a region of intensive agriculture and mining, two land uses that typically are not found mutually in other parts of the state. The upper and middle section of the Green River basin (which accounts for about two-thirds of this BMU) is mostly rural and small-scale agriculture in the form of livestock grazing with limited row cropping. As with all BMUs, physical and chemical monitoring form the primary basis for stream assessments for this use in large streams greater than 5th Strahler order. However, most pollutants included in the physicochemical monitoring will go undetected without also assessing biological communities such as macroinvertebrates that are integrators of these episodic pollutants. Agricultural chemicals in particular are intra-seasonally specific since pesticide and herbicide applications often are only applied after pest management data signal the damage is approaching economic threshold where chemical treatment is cost-effective. Thus, if chemical monitoring is not timed to coincide with these agricultural practices, the effects will go unnoticed during the growing season in conventional physicochemical monitoring. To better assess large rivers, appropriate biological indicators and protocol are under development on a national level.

There are 333 miles of RR streams identified in this BMU, the overwhelming majority of those miles in the Green River basin (Table 3.1.4-1). An additional 18.4 stream miles in the Green River basin are candidate exceptional waters (Table 3.1.4-2) and will be submitted for inclusion in 401 KAR 5:030 in the triennial review of 2008. These miles of candidate exceptional stream segments represent less than one percent of the total number of miles assessed for aquatic life use in this BMU. However, taken with the 333 miles of RR streams, this represents a significant percentage (13 percent) of assessed stream miles in the BMU. Given that finding RR streams was a priority in the first BMU cycle, it is likely additional RR stream miles will be relatively few as targeted monitoring emphasis shifts to TMDL monitoring. However, identifying new stream segments as exceptional (401 KAR 5:030) will be a part of KDOW's overall monitoring strategy.

Targeted Monitoring: Fish Tissue. Fish tissue samples were analyzed for mercury and PCB burden in the Green – Tradewater BMU. Of the 338 miles surveyed, 52 percent of sampled stream miles were found to be supporting (Table 3.3.1-5). The two pollutants of issue were mercury and PCBs. These nonsupporting water body segments are found in portions of these streams: Mud River; Town Branch; Drakes Creek; Green River; and West Fork Drakes Creek.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of *E. coli* and fecal coliform colonies to assess this use. There were 1,348 stream miles assessed in this BMU and 39 percent of those stream miles fully support that use (Table 3.3.1-5). Even though this is a mostly rural area, it contains extensive livestock grazing and row cropping in an area of extensive karst. Agriculture has the greatest combined source of these pollutants in this BMU (Table 3.3.2-1).

Targeted Monitoring: Domestic Water Supply. Out of 300 miles assessed in this BMU, all of those stream miles are fully supporting this use (Table 3.3.1-5).

Probability Biosurvey of Green – Tradewater BMU. The Green – Tradewater BMU was sampled according to EMAP and KDOW SOP (Methods for Assessing Biological Integrity Of Surface Waters in Kentucky), 2006. Because of significant wide-spread drought conditions in this BMU in 2003, comparisons to those results were problematic; therefore, trend information comparisons between the two monitoring years were not made. Thus, many headwater streams in 2003 that might have been expected to be part of the survey were excluded because of those drought conditions. As Table 3.3.2-6 shows, out of 9,991 miles of target stream resources, 9,445 miles were represented in the probability analysis. Once the probability data were extrapolated, 2,607 miles or 28 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 6,837 miles or 72 percent of wadeable streams were not fully supporting that use (Table 3.3.2-7 and Figure 3.3.2-3). This probability survey did find a considerably greater aquatic life use support level for this basin as compared to the upper Cumberland River and 4-Rivers basins (15 and 17 percent, respectively). These findings are not confounding considering these two BMUs and the intense land uses that are found in environmentally damaging on a large-scale that is ongoing in the Upper Cumberland – 4-Rivers BMU. The mountainous upper Cumberland basin also supports a delicately balanced aquatic habitat given the physical and chemical characteristics of its ecosystem. However, it should be noted the Green River basin is home to sensitive, uncommon aquatic fauna, especially the subterranean forms in the well-developed underground river systems.

Table 3.3.2-6. Aquatic use attainment results based on the 2004 probability biosurvey of the Green – Tradewater Rivers BMU.

Project ID	Green – Tradewater BMU Probability Survey
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Target Population	9,991 mi
Size of Non-Target Population	8,865 mi
Size of Target Sampled Population	9,445 mi
Designated Use	Aquatic Life
Attaining Full Use	2,607 mi
Not Attaining Full Use	6,837mi
Indicator	Biology (Macroinvertebrates)
Assessment Date	2005
Precision	93% at 95% Confidence Level

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results differed the least in this BMU, as compared to the Upper Cumberland – 4-Rivers BMU (Table 3.3.2-7). In this basin, there are 333 miles or 13 percent of targeted stream miles identified as RR aquatic habitats (Table 3.1.4-1). In this water-year, a number of miles were assessed as follow-up surveys on designated reference reach stream segments to monitor the conditions through cycle phases. As is the order of targeted monitoring within KDOW programs, a significant portion of the targeted streams are Strahler order 4 or greater watersheds, whereas probability monitoring design selects an equitable number of Strahler order 1 – 5 streams. These smaller watersheds manifest stress in biological communities to relatively smaller-scale perturbations than large watersheds, which can often assimilate more disturbances relative to watershed size. Also, the approach to locating sample stations differs significantly between the two biological programs. The targeted stations are located in the best available stream reach, whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly selected locations throughout the study area. To illustrate this, the Green – Tradewater BMU has 333 miles of RR streams, with 284 of those miles in the Green River basin alone. Reference reach stream miles are often representative of a fragment of the watershed that is an outstanding example of habitat and aquatic communities. These types of occurrences are an example of the biased monitoring strategies inherent to targeted monitoring that the probabilistic program avoids through random, unbiased design and protocol.

Figure 3.3.2-3. Proportions of aquatic life use support in Green - Tradewater Rivers BMU based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.

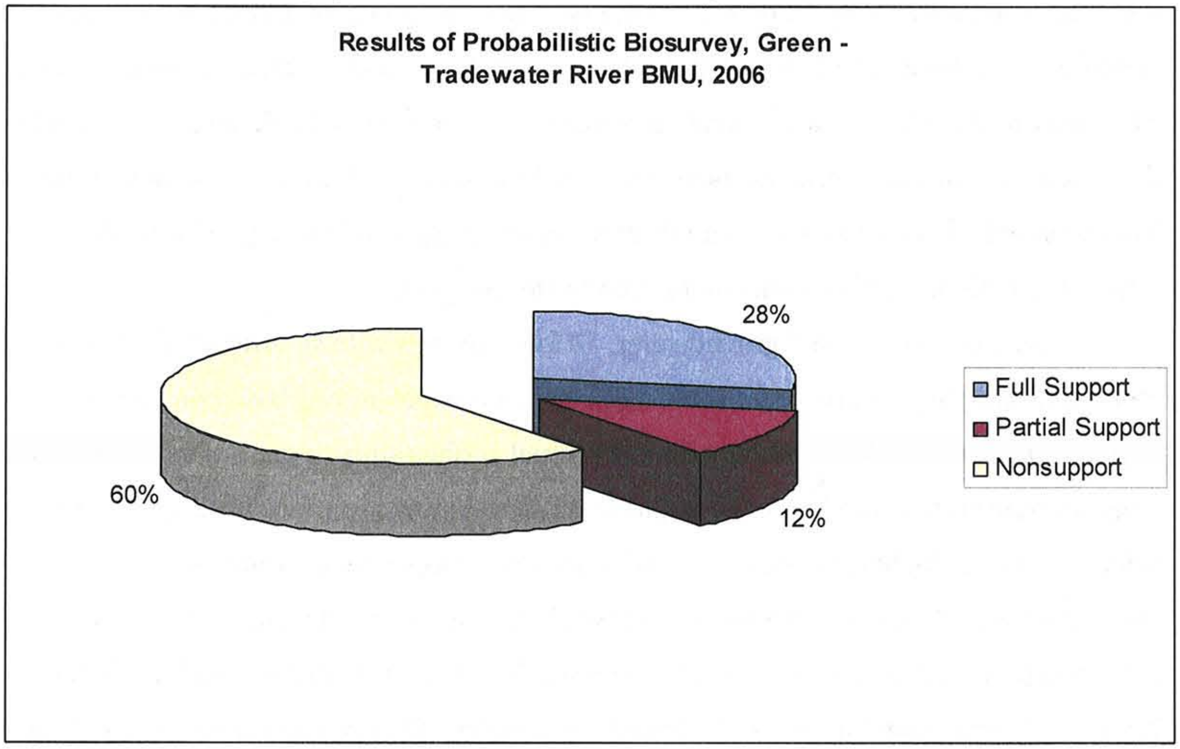


Table 3.3.2-7. Comparison of probabilistic and targeted monitoring results for aquatic life use in the Green – Tradewater Rivers BMU (Note: percentages rounded to nearest integer).

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	2,607	1,389	1,109	657	5,728	607
Percent	28	52	12	25	60	23

Integrated Surface and Groundwater Quality Assessment of Large Karst Springs in the Green River Basin. The purpose of this project was to assess the nonpoint source (NPS) impacts to groundwater in the Green – Tradewater River BMU, and to integrate ground- and surface water quality information with biological data to better define the nexus between the two flow systems. Groundwater and surface water are conjunctive systems, no where more directly so than in karst terrain. Surface water assessments in the well-developed karst terrain of the sinkhole plain are limited due to a lack of flowing surface streams. Therefore, karst basins represent large unassessed areas of contribution to the Green River basin. For example, Gorin Mill Spring, south of Munfordville, Kentucky, contributes approximately 10 percent of the base flow of the Green River. Subsurface conduits drain these karst basins that discharge to surface waters at discrete large springs. This integrated surface water/groundwater assessment addresses the deficiency caused by the lack of significant stream segments that can be assessed using conventional techniques. This approach also provides needed information on spring conditions relative to NPS impacts to both the surface water and groundwater programs.

To assess surface and groundwater, 10 karst springs with significant discharge were monitored monthly for one year (Table 3.3.2-8). Site selection was based on identifying large, well-developed karst basins where perennial surface streams are limited, and where large discrete springs discharge the drainage of these basins to surface waters. Other site selection criteria include accessibility and landowner cooperation. Additional considerations include whether these sites would provide new data, will support other programs (e. g., 305[b], TMDL, wellhead protection, etc.), and whether land use in the basins represents nonpoint source pollutants of concern. The drainage areas for most karst basins were previously identified. Additional groundwater tracer testing was conducted for two un-delineated basins.

Table 3.3.2-9 shows the uses assessed for springs and the miles from those assessments in the proper use support-level. The major cause (pollutants) found to exceed water quality standards for assessed springs in the Green River basin for warm water aquatic life use is "nutrient/eutrophication biological indicators" which accounts for 91 percent of causes. Primary contact recreation use assessment using *E. coli* as the indicator found 95 percent of spring miles not supporting that use. Given the nature of springs draining large, indeterminate watersheds, source of these causes are listed as "source unknown" and will be identified in intensive watershed monitoring related to TMDL development. Landowners or operators of these resources received copies of sample results with explanatory letters and other relevant material.

Table 3.3.2-8. Springs monitored in the Green River basin during water-year 2006-2007.

Spring Name	County	Karst Basin Area (mi^2)	Base Flow Discharge (ft^3/s)
Gorin Mill	Hart	152.4	24.0
Graham	Warren	122.3	19.8
Lost River Rise	Warren	58.8	12.4
Nolynn	Larue	56.4	4.6
McCoy	Hart	34.1	12.7
Skees Karst Window	Hardin	27.5	6.4
Mahurin	Grayson	25.3	2.1
Head of Rough River	Hardin	17.3	2.8
Goodman	Hardin	14.7	4.6
Mill	Grayson	7.1	3.9

Table 3.3.2-9. Individual designated use support summary for springs in Kentucky, 2008.

Designated Use	Total in State (miles)	Total Assessed (miles)	Supporting Water Quality Standards (miles)	Not Supporting Water Quality Standards (miles)	Size of Resource Not Assessed (miles)
Warm Water Aquatic Habitat	10.48	10.45	5.0	5.45	0.03
Fish Consumption	10.48	0	0	0	10.48
Primary Contact Recreation	10.48	9.95	0	9.95	0.53
Secondary Contact Recreation	10.48	0	0	0	10.48
Domestic Water Supply	0.03	0.03	0.03	0	0

3.3.3 Ohio River

ORSANCO assessed uses in the 664 miles of the Ohio River main stem that forms Kentucky's northern boundary and a summary of those findings are presented in the ORSANCO 2008 305(b) report. No reaches of the Ohio River fully support all uses. Drinking water and aquatic life use are fully supported in all river miles. Eighteen segments along this reach were not fully supporting primary contact recreation use due to pathogens. Of the 664 miles that form Kentucky's northern border, those 18 segments represent 350 miles (53 percent) that did not fully support the use. This limited support was often a result of combined sewer overflows (CSOs) during and immediately following rainfall events in and downstream of urban areas. All miles of the Ohio River partially supported the fish consumption use because of limited fish consumption advisories for PCBs and dioxin.

3.3.4 Assessment Results of Lakes and Reservoirs: Focus on Upper Cumberland – 4-Rivers and Green – Tradewater Rivers BMUs

Introduction. Since the initiation of the rotating basin approach in 1998, the commonwealth's significant publicly-owned lakes and reservoirs are monitored over a five-year cycle instead of the previous seven- to eight-year cycle. During this two-year reporting period, 50 lakes and reservoirs were monitored (maps located in Appendix C) and four were carry forward assessed reservoirs from 2000-01 water-years due to access restrictions in the Upper Cumberland – 4-Rivers BMU and Green – Tradewater BMU.

Designated uses in lakes consist of Warm Water Aquatic Habitat (WAH) (sometimes in conjunction with Cold Water Aquatic Habitat (CAH) in lakes with a two-story fishery) and Primary and Secondary Contact Recreation (PCR and SCR). Many reservoirs also have a domestic water supply (DWS) use. Indicators monitored or sampled for analysis to determine lake or reservoir health (water quality) may be found in Table 3.2.1-1.

3.3.4.1 Assessment of Trophic State and Use Support.

Trophic status was assessed in lakes by using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy, and it also provides for a distinction between oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic lakes. The growing season (April – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately. Use support in lakes was determined by criteria listed in Table 3.2.1-3.

3.3.4.2 Results

Statewide. Table 3.3.4.2-1 through 3.3.4.2-9 present statewide summaries of use support, impairments (causes) and sources of impairments of reservoirs, ponds and lakes in the state. The water quality assessment of lakes includes more than 95 percent of the publicly-owned lakes, ponds and reservoirs acreage of Kentucky (Table 3.3.4.2-1). Seventy-four of 127 lakes, ponds and reservoirs (58 percent) fully support their uses, and 53 (42 percent) do not support one or more uses. On an acreage basis, approximately 73 percent (778,108 acres) of the 1,072,470 designated uses-assessed acres fully support uses, and approximately 27 percent (294,362 designated use-acres) do not support one or more uses (Table 3.3.4.2-1 – 3).

Table 3.3.4.2-1. Individual use support summary for Kentucky reservoirs.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting	Size Not Assessed
Warm Water Aquatic Habitat	219,135	217,811	209,093	0	8,781	1,324
Cold Water Aquatic Habitat	2,410	2,410	2,410	0	0	0
Fish Consumption	216,135	204,664	112,209	0	92,455	14,471
Primary Contact Recreation Water	219,135	62,149	61,930	0	219	156,986
Secondary Contact Recreation Water	219,135	213,497	200,773	0	12,724	5,638
Domestic Water Supply	194,217	192,692	191,031	0	1,661	1,525

Table 3.3.4.2-2. Individual use support summary for Kentucky lakes.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting	Size Not Assessed
Warm Water Aquatic Habitat	571	571	342	0	229	0
Fish Consumption	571	63	0	0	63	508
Primary Contact Recreation Water	571	0	0	0	0	571
Secondary Contact Recreation Water	571	317	317	0	0	254

Table 3.3.4.2-3. Individual use support summary for Kentucky ponds.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting	Size Not Assessed
Warm Water Aquatic Habitat	4.8	0	0	0.0		4.8
Fish Consumption	4.8	4.8	3.3	0.0	1.5	0.0
Primary Contact Recreation Water	4.8	0.0	0.0	0.0	0.0	
Secondary Contact Recreation Water	4.8	0.0	0.0	0.0	0.0	4.8

Methylmercury and mercury in fish tissue were the most frequently identified pollutant, accounting for the most lake, pond and reservoir acres impacted (92,520 or statistically 100 percent of acres not supporting fish consumption use) (Table 3.3.4.4 – 6). Nutrients/eutrophication biological indicators and pH were the second and third most frequent impairments. A list of those causes and sources is presented in Tables 3.3.4.2-7 –

9. Sources "unknown" were most commonly identified as it relates to impairments affecting Kentucky's reservoirs and lakes; this related to the high frequency of mercury in fish tissue and methylmercury identified as the primary pollutant. This pollutant enters aquatic environments from multiple pathways. Ponds also had "unknown" as the most common source (Table 3.3.4.2-9) due to methylmercury. A fish consumption advisory for PCBs is in place on one reservoir of considerable size (Green River Lake), resulting in a high percentage of lake acres impacted by priority organics (Table 3.3.4.2-4). Agricultural-related sources, along with municipal point sources and septic systems, were the most commonly identified sources related to nutrient impairments (Tables 3.3.4.2-7 and 8). The indicator pH was the fourth most frequent "pollutant" with respects to reservoir and lake impairment. The listing of pH for standards exceedence affects CAH, WAH and PCR and SCR uses (Table 3.3.4.2-4). Dissolved oxygen was displaced to fifth most frequent "pollutant" in these waters (Table 3.3.2-4 and 5). A related problem was the pollution-indicator, dissolved gas super-saturation, which often occurs with excess nutrients during daylight hours as photosynthesis from excess algae occurs. Naturally shallow lake or reservoir basins, or those that have excessive sedimentation resulting in shallow basins, often provide suitable habitat for the proliferation of nuisance aquatic weeds that impair secondary contact recreation and account for the fifth highest cause of use nonsupport. Natural conditions such as manganese releases from anoxic hypolimnetic water (deepest water-layer in stratified reservoirs and lakes) and nutrients (resulting in high production of aquatic macrophytes and plankton) in runoff from relatively undisturbed watersheds affect domestic water supply and secondary contact uses, respectively. Suspended solids from surface mining activities have decreased in severity as a source from previous years but continue to impede full secondary contact recreation use in one eastern Kentucky reservoir (Buckhorn Lake).

Trophic state was determined for the number of acres and lakes for the four possible categories of TSI. For this presentation of data, a distinction between lakes (natural waterbodies) and reservoirs (manmade lakes or impoundments) is made. Tables 3.3.4.2-10 and 11 present these results.

Table 3.3.4.2-4. Number of acres of Kentucky reservoirs, lakes and ponds affected by individual causes (pollutants).

Cause	Total Size
Methylmercury	78,313
Mercury in Fish Tissue	14,142
Nutrient/Eutrophication Biological Indicators	9,724
pH	8,489
Oxygen, Dissolved	8,388
PCB in Fihs Tissue	8,210
Dissolved Gas Supersaturation	3,864
Total Suspended Solids (TSS)	3,040
Sedimentation/Siltation	2,417
Organic Enrichment (Sewage) Biological Indicators	1,264
Taste and Odor	1,171
Aquatic plants (macrophytes)	711
Chlorophyll-a	548
Habitat Assessment (Streams)	339
Manganese	317
Aquatic Algae	169
Dissolved oxygen saturation	64
Impairment Unknown	43

Table 3.3.4.2-5. Number of acres of Kentucky lakes (natural) affected by causes (pollutants).

Cause	Total Size
Oxygen, dissolved	229
Nutrient/Eutrophication Biological Indicators	229
Methylmercury	36
Mercury in fish tissue	27

Table 3.3.4.2-6. Number of acres of Kentucky ponds affected by cause (pollutant).

Cause	Total Size
Methylmercury	1.5

Table 3.3.4.2-7. Sources of causes (pollutant) to Kentucky reservoirs.

Source	Total Size
Atmospheric Deposition - Toxics	68,888
Source Unknown	43,470
Upstream Source	12,724
Agriculture	9,151
Industrial Point Source Discharge	8,210
Municipal Point Source Discharges	6,129
Surface Mining	4,270
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	4,232
Livestock (Grazing or Feeding Operations)	3,356
Internal Nutrient Recycling	3,212
Natural Sources	2,877
Rural (Residential Areas)	317
Littoral/shore Area Modifications (Non-riverine)	512
Impacts from Abandoned Mine Lands (Inactive)	219
Unspecified Urban Stormwater	170
Non-irrigated Crop Production	169
Crop Production (Crop Land or Dry Land)	137
Grazing in Riparian or Shoreline Zones	99
Habitat Modification - other than Hydromodification	99
Septage Disposal	98
Golf Courses	78
Streambank modifications/destabilization	37
Post-development erosion & sedimentation	37
Contaminated Sediments	18

Table 3.3.4.2-8. Sources of causes (pollutant) to Kentucky lakes (natural).

Source	Total Size
Natural Sources	193
Agriculture	193
Non-irrigated crop production	36
Atmospheric deposition – toxics	36
Rural (residential areas)	36
Source Unknown	27

Table 3.3.4.2-9. Source of cause (pollutant) to Kentucky ponds.

Source	Total Size
Source Unknown	1.5

Table 3.3.4.2-10. Trophic state of reservoirs in Kentucky

Trophic State	Number of Lakes	Total Size
Oligotrophic	10	62,602
Mesotrophic	30	23,161
Eutrophic	54	131,705
Hypereutrophic	1	317
Dystrophic	0	0

Table 3.3.4.2-11. Trophic state of lakes in Kentucky

Trophic Status	Number of Lakes	Total Size
Oligotrophic	0	0
Mesotrophic	0	0
Eutrophic	9	308
Hypereutrophic	3	263

Upper Cumberland River Basin. The fact that the majority of Kentucky's oligotrophic (infertile, low primary production) reservoirs are located in this basin is related to the geology of this mountainous and high plateau basin. Of the fully supporting reservoirs in this basin, two are eutrophic, three are mesotrophic and one is oligotrophic (Tables 3.3.4.2-12). In this basin, there were 11 reservoirs monitored or evaluated (evaluated for DWS only), nine were fully supporting uses and three did not support fully all uses (Table 3.3.4.2-12 – 14). Of reservoirs fully supporting uses, the trend in trophic state is decreasing toward a less nutrient-enriched system on five reservoirs, stable on two and increasing on two as compared to data from 2000. Of those reservoirs less than full support of one or more uses, one reservoir is stable and another is slightly increasing in trophic state (Table 3.3.4.2-12-14). Nutrient/eutrophication biological indicators is the most common impairment affecting water quality conditions in these reservoirs (Tables 3.3.4.2-13 and 14). Excess nutrients (phosphorus and nitrogen) eventually result in depleted or lowered DO in the water column. Sources of those impairments are listed in Tables 3.3.4.2-13 and 14.

Table 3.3.4.2-12. Upper Cumberland River Basin reservoirs that fully support assessed uses.

Lake	Acres	County	Trophic State	Eutro-phication Trend	Uses
Cannon Creek	243	Bell	Oligotrophic	Stable	C/WAH FC SCR DWS
Cranks Creek	219	Harlan	Oligotrophic	Increasing (degrading)	WAH SCR
Dale Hollow Reservoir	4300	Clinton	Oligotrophic	Decreasing (improving)	WAH FC P/SCR DWS
Linville	273	Rockcastle	Eutrophic	Stable	C/WAH FC P/SCR DWS
Laurel Creek	88	McCreary	Mesotrophic	Decreasing (degrading)	WAH FC P/SCR DWS
Laurel River	6060	Whitley & Laurel	Oligotrophic	Decreasing (improving)	WAH, CAH, SCR, DWS
Martin's Fork	334	Harlan	Mesotrophic	Decreasing (improving)	C/WAH FC P/SCR DWS
Tyner	87	Jackson	Mesotrophic	Increasing (degrading)	WAH FC P/SCR DWS
Wood Creek	672	Laurel	Oligotrophic	Decreasing (improving)	WAH FC P/SCR DWS

Table 3.3.4.2-13. Upper Cumberland River basin reservoirs partially supporting assessed uses.

Lake/Reservoir	Acres	County	Trophic State (↓↑↔)[a]	Impaired Use	Cause (pollutant)	Source
Chenoa	37	Bell	Mesotrophic ↔ (stable)	SCR	Aquatic plants (macrophytes)	Post-development erosion and sedimentation, streambank modification/destabilization, shallow lake/reservoir basin
Corbin City	139	Laurel	Mesotrophic (insufficient trend data)	WAH	Chlorophyll *a*, nutrient/eutrophication biological indicators, organic enri-chment (sewage) biological indicators	Internal nutrient recycling, municipal point source discharges, agriculture
Cumberland	50,250	Pulaski, Russell, Wayne	Oligotrophic ↑ (degrading)	FC	Methylmercury	Atmospheric deposition - toxics

[a]Symbols represent decreasing, increasing or stable as it relates to trophic state trend

Table 3.3.4.2-14. Upper Cumberland River basin reservoirs not supporting assessed uses.

Lake/Reservoir	Acres	County	Trophic State	Use Impaired	Cause of Impairment	Source of Impairment
Corbin City	139	Laurel	Mesotrophic (insufficient trend data)	DWS	Nutrient/eutrophication biological indicators, organic indicators (sewage) biological indicators, taste and odor	Internal nutrient recycling, municipal point source discharges, agriculture

4-Rivers Basins. There were 10 lakes and reservoirs monitored in 2005. Of those 10, six are fully supporting assessed uses, four are partially supporting assessed uses and one is not supporting assessed uses (Tables 3.3.4.2-15 – 17). Of the fully supporting lakes and reservoirs (in the 4-Rivers basins, five are eutrophic and one is mesotrophic (Tables 3.3.4.2-15). The trends in trophic state of all reservoirs that fully support uses are increasing, with the exception of Blythe Lake (mesotrophic) as compared to 2000 data (Table 3.3.4.2-15). The remaining lakes and reservoirs are less than fully supporting all assessed uses (Tables 3.3.4.2-16 and 17). These lakes most commonly are less than full support for SCR based on proliferation of aquatic macrophytes over a substantial portion of open-water area. This can be attributed to shallow basins in meso- to eutrophic trophic state. However, an important trend concerning these lakes is that of decreasing trophic state in all but one, which had insufficient data to make a trend determination (Tables 3.3.4.2-16 and 17). Methylmercury and mercury (in fish tissue) are found to be at levels above criteria in both lakes where fish flesh was analyzed for contaminants. Hematite Lake (reservoir) has excess nutrients (phosphorus and nitrogen) that result in the depletion of adequate DO in the water column through excess primary (phytoplankton) production; conversely, the excess algal growth will result in super-saturation of DO during photosynthesis (Table 3.3.4.2-17).

Table 3.3.4.2-15. 4-Rivers basins (lower Cumberland, lower Ohio, Mississippi and Tennessee rivers) lakes and reservoirs that fully support assessed uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Energy	370	Trigg	Eutrophic	Increasing (degrading)	WAH, FC, SCR
Barkley	45,500	Lyon	Eutrophic	Increasing (degrading)	WAH, FC, P/SCR, DWS
Blythe	89	Christian	Mesotrophic	Decreasing (improving)	WAH, FC, SCR
Morris	170	Christian	Eutrophic	Increasing (degrading)	WAH, P/SCR, DWS
Turner	61	Ballard	Eutrophic	Increasing (degrading)	WAH, FC, SCR
Kentcuky	48,100	Calloway	Eutrophic	Increasing (degrading)	WAH, FC, P/SCR, DWS

Table 3.3.4.2-16. 4-Rivers basins (lower Cumberland, lower Ohio, Mississippi and Tennessee rivers) Kentucky River Basin lakes and reservoirs that partially support assessed uses.

Lake	Acres	County	Trophic State $(\downarrow, \uparrow, \leftrightarrow)$[a]	Use Impaired	Cause of Impairment	Source of Impairment
Hematite	90	Trigg	Mesotrophic $\downarrow$ (degrading)	SCR	Aquatic plants (macrophytes)	Littoral/shore area modifications, natural sources, shallow lake/reservoir basin
Honker	190	Lyon	Mesotrophic $\downarrow$ (degrading)	SCR	Aquatic plants (macrophytes)	Littoral/shore area modifications, natural sources, shallow lake/reservoir basin
Fish	27	Ballard	Eutrophic (insufficient trend data)	WAH, FC, SCR	Mercury in fish tissue	Source unknown
Metropolis	36	McCracken	Eutrophic $\downarrow$ (degrading)	WAH, FC, SCR	Methylmercury, dissolved oxygen, nutrient/eutro-phication biological indicators	Atmospheric deposition, internal nutrient recycling, non-irrigated crop production, rural (residential area), shallow lake/reservoir basin

[a]Symbols represent decreasing, increasing or stable as it relates to trophic state trend

Table 3.3.4.2-17. 4-Rivers basins (lower Cumberland, lower Ohio, Mississippi and Tennessee rivers) reservoir not supporting assessed uses.

Lake	Acres	County	Trophic State (↓, ↑, ↔)[a]	Use Impaired	Cause of Impairment	Source of Impairment
Hematite	90	Trigg	Mesotrophic ↓ (improving)	WAH	Dissolved oxygen, nutrient/eutrophication biological indicators	Source unknown

[a]Symbols represent decreasing, increasing or stable as it relates to trophic state trend

Green – Tradewater Rivers BMU. There were 29 reservoirs monitored in this BMU, the largest number of monitored publicly-owned reservoirs and lakes in the five BMUs. Twenty of those reservoirs are fully supporting their assessed uses (Table 3.3.4.2-18), and nine are partially supporting one or more assessed uses (Table 3.3.4.2-19). Of those fully supporting reservoirs, 16 are eutrophic and four are mesotrophic; there are no monitored oligotrophic reservoirs in this BMU (Tables 3.3.4.2-18). The trend in trophic state of five reservoirs that fully support uses is increasing (degrading), nine are stable and six are decreasing (improving) compared to 2000 data (Table 3.3.4.2-15). The remaining reservoirs (nine) are less than fully supporting all assessed uses (Tables 3.3.4.2-19). As a group, these lakes are less than full support for a variety of uses, and indicate no recognized pollutant-trend on a BMU basis. Secondary contact recreation use is impaired from a proliferation of aquatic macrophytes over a substantial portion of open-water area sedimentation/siltation and excess nutrients (Table 3.3.4.2-19). The other most frequently impaired use is fish consumption due to mercury tainted fish flesh. An important trend of note concerning the reservoirs in this BMU is that 20 of those reservoirs monitored in this cycle have decreasing or stable (improving or holding steady) trophic trend; whereas, six reservoirs are increasing (degrading) per trophic state (Tables 3.3.4.2-18 – 19). Those reservoirs with insufficient data to determine trophic state trend were not monitored due to lack of access as of this monitoring cycle. Nutrients and excessive sedimentation/siltation are two pollutants of additional concern with these reservoirs.

Table 3.3.4.2-18. Green – Tradewater Rivers BMU reservoirs that fully support all assessed uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Barren River	10,000	Allen	Eutrophic	Increasing (degrading)	WAH, FC, P/SCR, DWS
Briggs	19	Logan	Eutrophic	Decreasing (improving)	WAH, FC, SCR
Freeman	160	Hardin	Eutrophic	Decreasing (improving)	WAH, FC, SCR
Grapevine	50	Hopkins	Mesotrophic	Stable	WAH, FC, SCR
Washburn	26	Ohio	Eutrophic	Decreasing (improving)	WAH, FC, SCR
Liberty	79	Casey	Mesotrophic	Decreasing (improving)	WAH, FC, SCR, DWS
Metcalfe County	22	Metcalfe	Eutrophic	Stable	WAH, FC, SCR
Mill Creek	109	Monroe	Eutrophic	Increasing (degrading)	WAH, FC, SCR, DWS
Nolin River	5,790	Grayson	Eutrophic	Stable	WAH, FC, P/SCR, DWS
Salem	99	Larue	Eutrophic	Increasing (degrading)	WAH, FC, SCR, DWS
Shanty Hollow	135	Warren	Eutrophic	Stable	WAH, FC, SCR
Spurlington	36	Taylor	Eutrophic	Decreasing (improving)	WAH, FC, SCR
Beshear	760	Caldwell	Eutrophic	Stable	WAH, FC, P/SCR, DWS
Peewee	360	Hopkins	Eutrophic	Increasing (degrading)	WAH, FC, SCR, DWS
Loch Mary	135	Hopkins	Mesotrophic	Stable	WAH, FC, SCR, DWS

Table 3.3.4.2-18 (cont.). Green – Tradewater Rivers BMU reservoirs that fully support all assessed uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Moffit	49	Union	Eutrophic	Stable	WAH, FC, SCR
Pennyrile	47	Christian	Mesotrophic	Decreasing (improving)	WAH, FC, SCR
Kingfisher	30	Daviess	Eutrophic	Stable	WAH, FC, SCR
George	53	Crittenden	Eutrophic	Increasing (degrading)	WAH, FC, SCR, DWS
Mauzy	84	Union	Eutrophic	Stable	WAH, FC, SCR

Table 3.3.4.2-19. Green – Tradewater Rivers BMU reservoirs that partially support assessed uses.

Lake	Acres	County	Trophic State (↓, ↑, ↔)[a]	Use Impairment	Cause of Impairment	Source of Impairment
Campbellsville City	63	Taylor	Eutrophic ↓ (improving)	SCR	Sedimentation/siltation, aquatic plants (macrophytes)	Upstream source, natural sources
Caneyville City	75	Grayson	Eutrophic (insufficient trend data)	SCR, DWS	Sedimentation/siltation, nutrient/eutro-phication biological indicators	Natural sources, shallow lake/reservoir basin
Green River	8,210	Taylor	Eutrophic ↔ (stable)	FC	Mercury in fish tissue, PCB in fish tissue	Industrial point source discharge, source unknown
Luzerne	55	Muhlenberg	Mesotrophic (insufficient trend data)	DWS	Nutrient/eutrophication biological indicators	Source unknown
Malone	826	Logan	Eutrophic ↔ (stable)	FC	Mercury in fish tissue	Source unknown
Rough River	5,100	Hardin	Mesotrophic ↑ (degrading)	FC	Mercury in fish tissue	Source unknown
Spa	240	Logan	Eutrophic ↔ (stable)	SCR	Chlorophyll *a*, sedimentation/siltation, habitat assessment (lakes)	Natural sources, agriculture
Carpenter	64	Daviess	Eutrophic ↔ (stable)	WAH	Dissolved oxygen, dissolved oxygen saturation, nutrient/eutrophication biological indicators	Upstream source, agriculture
Scenic	18	Henderson	Eutrophic (insufficient trend data)	WAH	Nutrient/eutrophication biological indicators	Contaminated sediments, internal recycling

[a]Symbols represent decreasing, increasing or stable as it relates to trophic state trend

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